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COLORADO RIVER AQUEDUCT

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THE

METROPOLITAN WATER DISTRICT

OF

SOUTHERN CALIFORNIA

COLORADO RIVER AQUEDUCT

LOS ANGELES, CALIFORNIA
MAY, 1934

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Colorado River Aqueduct

THE DISTRICT — ITS GOVERNMENT, BOUNDARIES, PURPOSE, POPULATION, AND FINANCIAL RESOURCES; WATER RIGHTS, SURVEYS, PLANS AND ESTIMATES, POWER REQUIRED, FINANCING, PLAN OF REPAYMENT, OFFICERS AND DIRECTORS.

Nature and Composition of District

The Metropolitan Water District of Southern California is a public corporation of the State of California, organized in 1928 under authority of the State Metropolitan Water District Act of 1927. It is composed of the following thirteen member cities: Anaheim, Beverly Hills, Burbank, Compton, Fullerton, Glendale, Long Beach, Los Angeles, Pasadena, San Marino, Santa Ana, Santa Monica, and Torrance.

Purpose

The District was organized for the purpose of supplying its member cities with water for domestic and industrial uses and incidentally to provide a potential water supply for such surrounding areas as may find it advantageous to join in the enterprise. Its objective at the present time is the construction of an aqueduct and delivery system for conveying water from the Colorado River to its member cities. The construction of this aqueduct is well under way.

Government

The District is governed by a board of directors comprised of at least one director from each member city, the voting power being distributed among the member cities upon the basis of one vote for each ten million dollars assessed valuation, with the provision that no one city shall have more than 50% of the voting strength of the board. The members of the board of directors are appointed by the executive officers of the member cities with the consent and approval of the governing bodies thereof. The District has authority to acquire, construct, and operate a water works system, do all the things incidental to these functions, and sell water and levy taxes to provide funds for carrying on its business and for paying interest and principal of its bonded indebtedness.

Environment

The region within which the cities of the Metropolitan Water District are situated embraces the fertile plain surrounding the City of Los Angeles and extending to Redlands on the east and Newport Beach on the south. There are 2,200 square miles or 1,400,000 acres



Typical citrus development at foot of Mt. San Bernardino near Redlands

of first-class habitable lands within this basin. Citrus fruits and semi-tropical vegetation grow luxuriantly. The climate is unsurpassed. The region is very attractive as a place of residence and as the site of an intense industrial development. Labor is plentiful and foodstuffs are abundant. The oil fields of Southern California provide an abundant and cheap supply of fuel, and the Los Angeles harbor is an open door to the raw material markets of the world.

The region is adequately served by three transcontinental railway systems, and is covered by a complete grid of paved highways. There are street car, interur-



Coastal plain of Southern California.

ban, bus, and truck facilities for every local transportation need. National and international air lines afford quick passenger, mail, and express service to all parts of the world. Electric light and power services are universally available, and gas and domestic water lines are found almost everywhere, even in the rural sections. Educational, religious, and recreational facilities are unsurpassed.

Population Growth

This region has experienced a remarkable increase in population during the past few decades. Growth has been particularly rapid since about 1910. There is every reason to expect that development will continue until the natural resources of the region are absorbed. Past and estimated population growths are as shown on the accompanying table.

Past and Predicted Population Growth

	Past Growth		U. S. Census Reports	
Year	Present member cities	Per cent increase	Entire basin	Per cent increase
1890	62,322		140,540	
1900	123,294	98	235,820	68
1910	391,595	218	668,038	183
1920	737,483	88	1,085,000	62
1930	1,665,833	126	2,491,000	130
	Predicted for Future			
1940	2,500,900	50	3,717,000	49
1950	3,360,200	34	4,940,000	33
1960	4,119,500	23	5,935,000	20
1970	4,824,300	17	6,860,000	16
1980	5,310,500	10	7,525,000	10

Economic Growth

Economic growth has kept full pace with increase in population. The value of agricultural products has increased nearly 400% in two decades, and other values have increased even more rapidly. The petroleum industry has grown to enormous proportions, and the harbor tonnage has increased from a nominal amount in 1909 to nearly 26,000,000 tons in 1929. There were 1,464 manufacturing plants in the basin in 1909; 3,721 in 1919; and 5,105 in 1929.

Total receipts from federal income taxes, both corporate and individual, for the Sixth Internal Revenue District, comprising the ten Southern California counties, increased from $35,106,613 in 1920 to $60,524,982 in 1930, or over 72% in the decade.

Combined production of electrical energy by the four largest Southern California producers increased from 1,427,692,495 kilowatt hours in 1920 to 4,253,161,457 kilowatt hours in 1930, or nearly 300%.

Volume of freight loaded and unloaded, as reported from 20 stations on five different carriers in the metropolitan area, increased from 267,044 carloads in 1920 to 377,655 in 1930, or over 41% in the decade.

In volume of water-borne commerce as evidenced by total inbound and outbound cargo tonnage, the Los Angeles-Long Beach port stands second among all United States harbors, and is the world's first oil exporting port.

The following table gives some idea of the general growth of business activities in the metropolitan area:

Values of Business Transactions	1909	1919	1929
Value of farm products	$30,580,909	$107,062,690	$ 137,103,803
Value of mfg. products	71,237,818	440,822,432	1,341,654,227
Value of water-borne commerce		153,919,010	1,055,808,494
Total wholesale sales	.....	.....	1,597,210,364
Total retail sales	.....	.....	1,347,890,000

Assessed Valuation

The assessed valuation of taxable property within the District area has always increased more rapidly than the population up to 1930, since which time a readjustment of the assessment ratio has caused a temporary recession. Assessed values of real and personal property and the value of such assessments per capita, in the present thirteen cities of the District, have increased since 1910 as follows:

	Present Member Cities		Entire Basin	
Year	Assessed value	Per capita	Assessed value	Per capita
1910-11	$ 284,000,000	$ 725	$ 529,992,000	$ 793
1920-21	668,000,000	906	995,206,000	917
1930-31	2,431,397,250	1460	3,581,261,000	1438
1933-34	1,654,403,890	973*	Data not yet available	

* Based on estimated present population of 1,700,000.

The latest population and assessed valuation figures for the individual cities of the District are as follows:

City	Population 1930	Assessed value 1933-34
Anaheim	10,995	$ 6,470,965
Beverly Hills	17,429	49,253,195
Burbank	16,662	17,950,175
Compton	12,516	6,842,955
Fullerton	10,860	10,124,080
Glendale	62,736	52,322,855
Long Beach	142,032	125,515,875
Los Angeles	1,238,048	1,216,288,975
Pasadena	76,086	81,988,410
San Marino	3,730	11,780,480
Santa Ana	30,322	17,585,745
Santa Monica	37,146	41,872,580
Torrance	7,271	16,407,600
Totals	1,665,833	$1,654,403,890



Typical view of industrial plants in metropolitan area. SPENCE

The foregoing figures for population and assessed values are for the present District cities. The metropolitan area contains many other populous communities and much potential area, expected to develop steadily under existing favorable conditions, if ample water supply is made available. The population of the basin in 1930 was 2,491,000 or 44% of the entire state of California and the assessed valuation was $3,581,261,000 or 48% of the total of comparable property for the state.

The assessed valuations shown do not include the operative property of public utilities and the property of public corporations exempt from taxation. Legislation enacted in 1933 permits the inclusion of operative property in the taxable wealth of the District after January, 1935. Assessed values theoretically represent 50% of real values in Los Angeles County and 40% in Orange County.



Large oil and gas fields supply Southern California with ample fuel and a large exportable surplus.

Present Water Resources

The region is naturally semi-arid, the annual rainfall being approximately 15 inches. The mountain areas tributary to the basin are not large and natural stream flow is limited. The rainfall occurs in a short wet season in the winter. In order that the surplus may be useful, it must be carried over to the dry season in some form of storage. Fortunately, the necessary storage is provided by natural means—the entire basin is underlaid by deep porous beds of alluvium. Surplus rainfall and flood waters seep down into these beds and are thus retained, to be removed by pumping as required for agricultural, domestic, and industrial purposes. Percolation is assisted where required by the construction of detention reservoirs and spreading works; however, even with the most complete conservation the water derived from local rainfall sources is inadequate for the needs of the community.

The areas immediately outside of the hills encircling



Downtown Los Angeles from the air. FAIRCHILD

the valley are arid and yield practically no runoff. It is therefore necessary in the development of the region to go great distances to secure the waters needed to supplement local supplies. Such long-distance importation began with the construction of the present Owens River aqueduct of the City of Los Angeles, which extends approximately 250 miles northward to tap the snow banks of the high Sierras. This aqueduct was completed in 1913 and is capable of delivering 450 cubic feet of water per second into this valley, or such smaller flow as may be available at the source of supply.

Present Deficiencies in Supply

The entire amount of water now being developed and used in the metropolitan area for all purposes and from local and outside sources is a little more than 1,000,000 acre feet per year. This amount exceeds the average yield of the sources from which it is being drawn by an appreciable percentage. This excess of use over normal supply is made possible by the fact that much of the water is derived from wells driven into the immense gravel beds underlying the area, which were filled with water prior to the settlement of California. Many of these wells have been over-pumped until they have gone dry, leaving their owners without a water supply. The water levels in practically all wells in the basin are dropping continuously. Large areas have been over-pumped to the extent that the fresh water table is lower than sea level and salt water intrusion has ruined large underground water supplies. Unless this condition is promptly relieved, growth within the metropolitan area must cease and retrogression is inevitable. Some further outside source of supply must be made available. At least double the present supply will be needed within the readily predictable future.



Los Angeles-Long Beach harbor stands second in the United States for total water borne commerce.

The Colorado River as a New Source of Supply

Opportunity for the development of the needed supply is being created by the construction, by the United States Government, of the Boulder dam on the Colorado River. Long records of flow show that when properly controlled and conserved, the waters of the



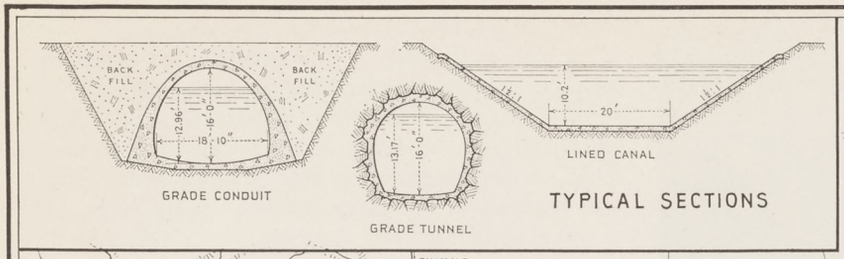
Parker damsite on the Colorado River.

Colorado River are ample to supply the needs of the District, without disturbing any existing diversion rights. Careful tests by federal, state, city, and District authorities, both laboratory and clinical, have shown Colorado River water to be of good quality, free from injurious chemicals in deleterious amounts. There is available no other source of supply suitable in quality and quantity and the people of the metropolitan area have no alternative but to undertake this great water supply project. Fortunately, Colorado River water can be brought into the District at a feasible cost.

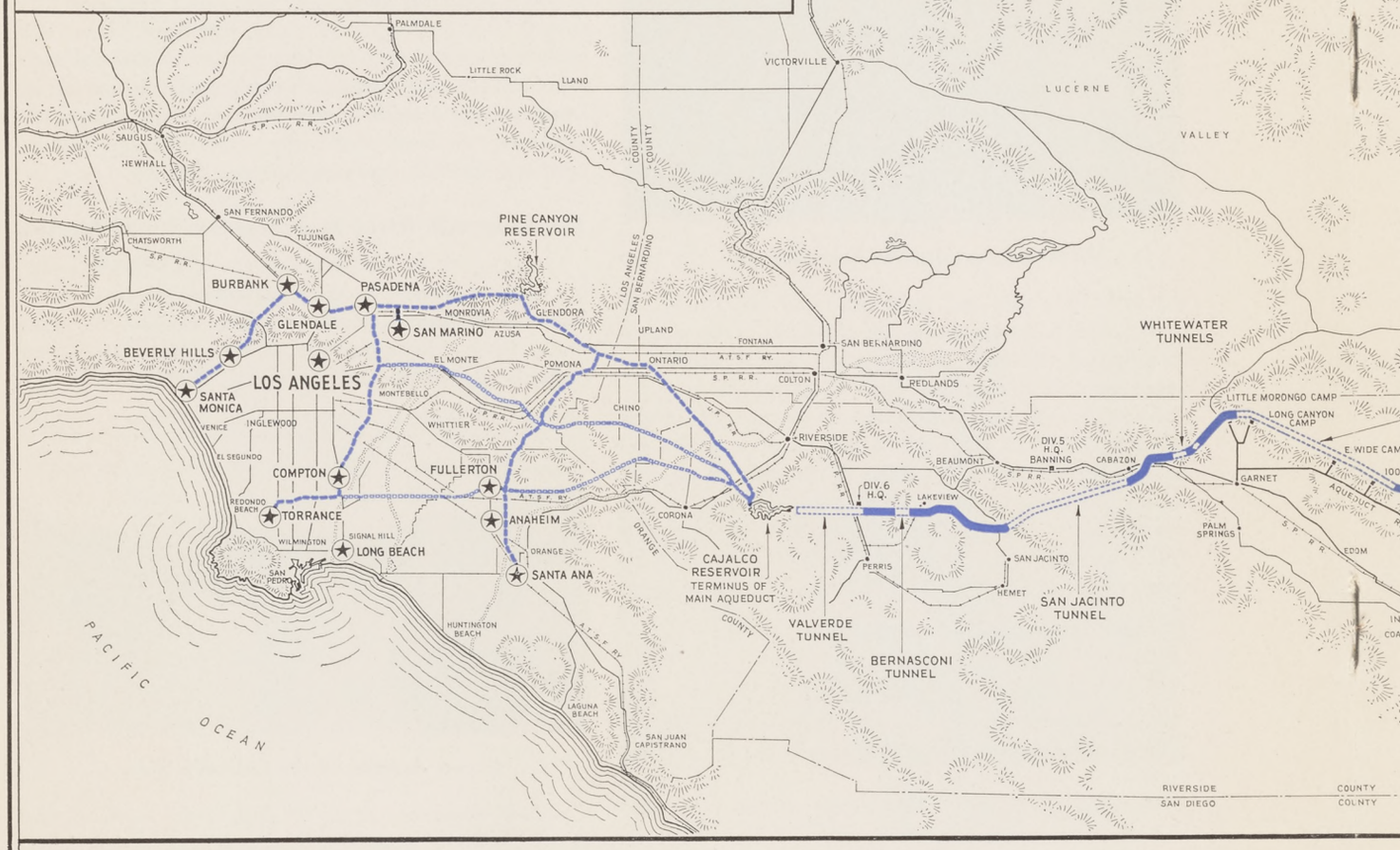
Water Rights and Power Contracts

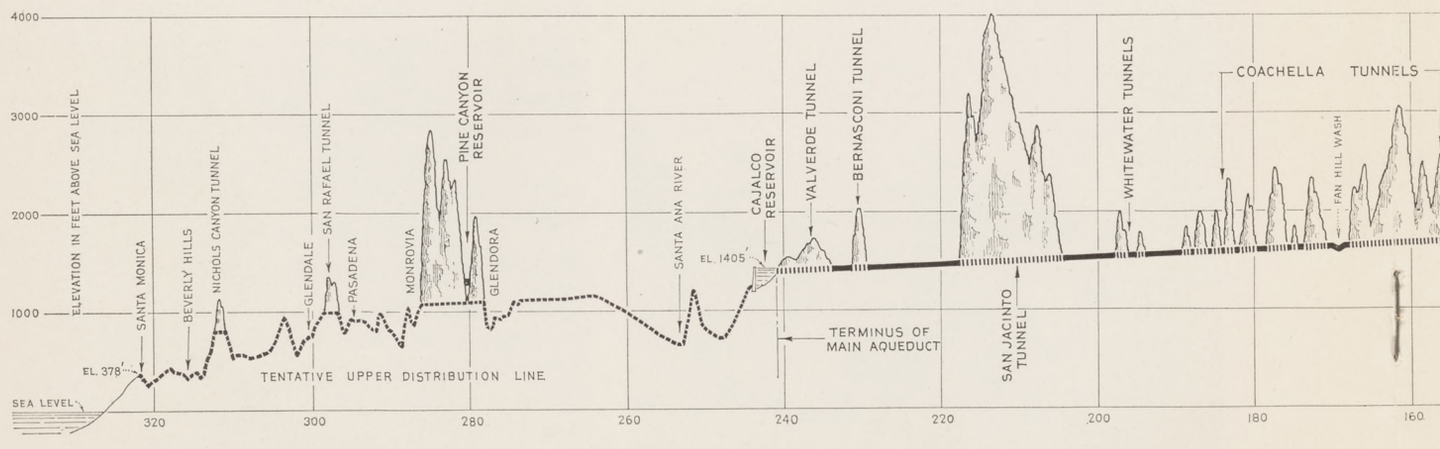
The District has entered into definite agreements with other prospective users of Colorado River water in California as to the division of the waters to be allocated to California. These agreements concede to the District the right to an annual diversion of 1,100,000 acre feet.

The District has accordingly filed on such a diversion from the Colorado River at the Parker damsite, under

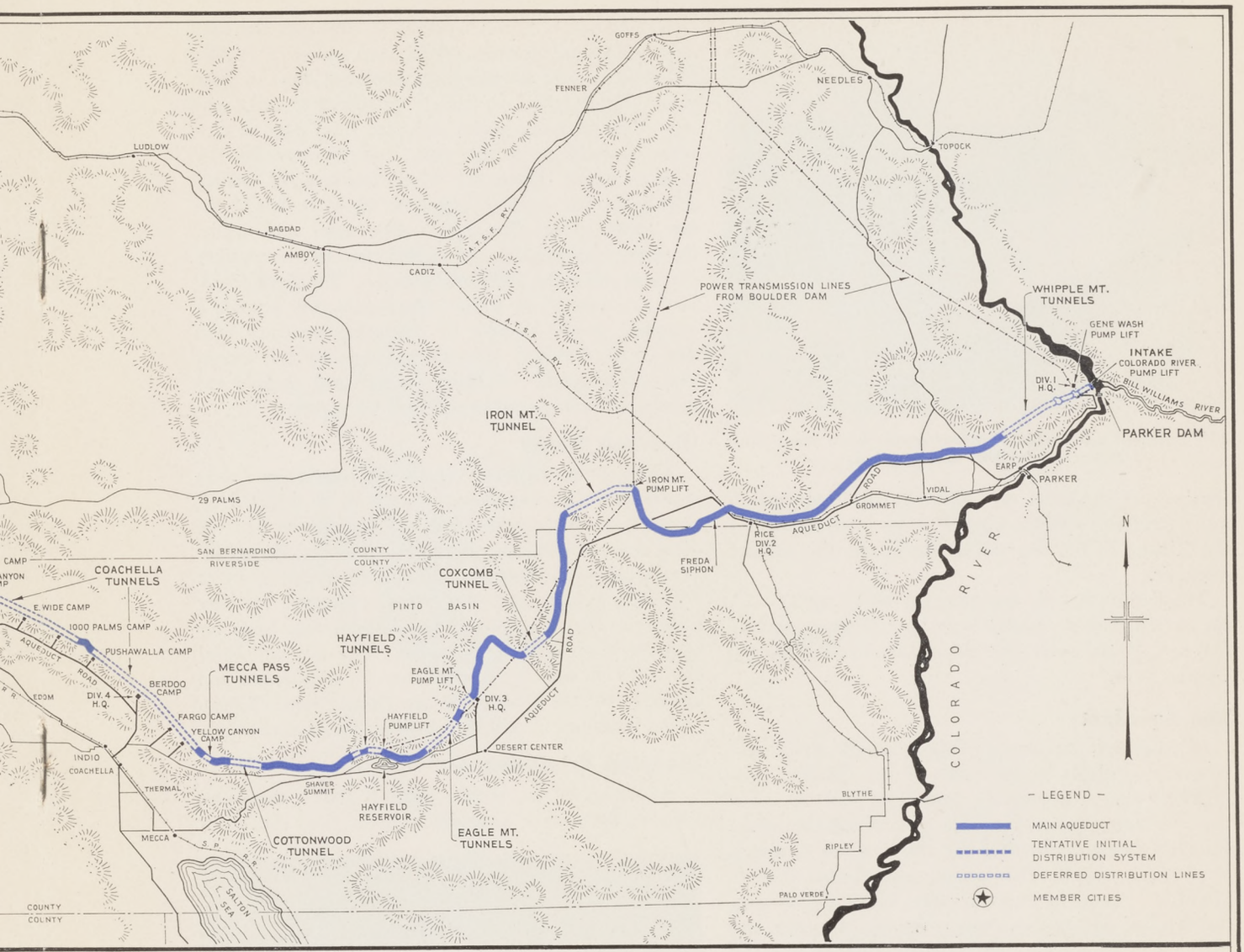


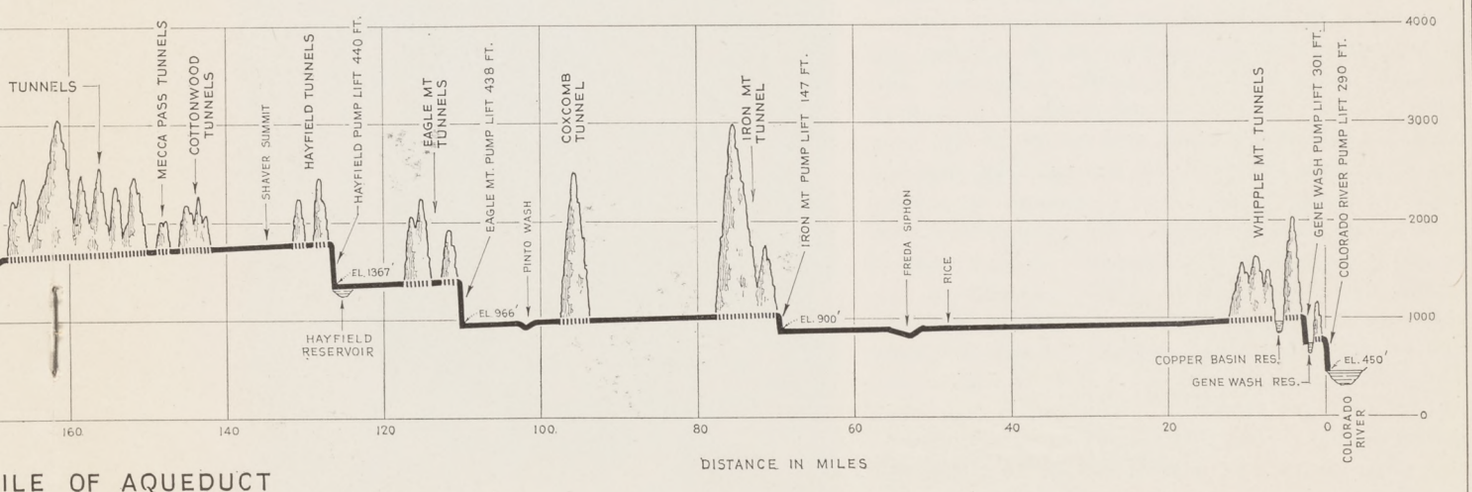
TYPICAL SECTIONS





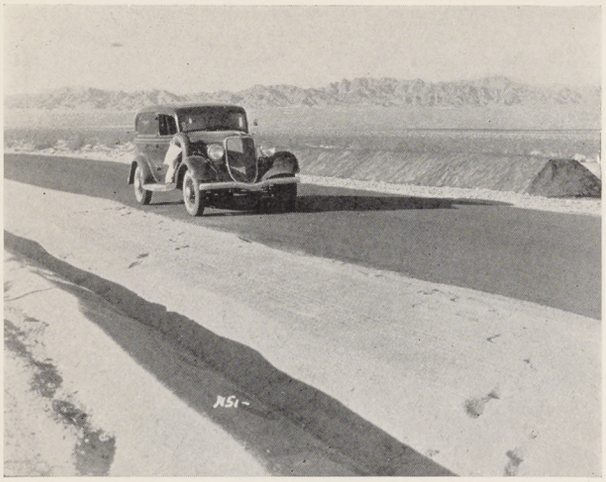
PROFILE OF





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148 miles of oil surfaced desert roads have been built to serve aqueduct construction.

the laws of the State of California, and has entered into a contract with the United States Government for the delivery of this amount of water from the Boulder reservoir.

The District has likewise entered into a contract with the Government for power from Boulder dam to pump Colorado River water over the mountains and into the District area.

The Aqueduct

In order that the waters of the Colorado River may be made available to the cities of the District, it is necessary that a conduit of some kind be built across the intervening desert area. The general location of the aqueduct being constructed for this purpose is shown on the map, page 9. This location was selected after an exhaustive study of every possible route for crossing the desolate and rugged region between the river and the area to be served. The portion designated as the main aqueduct extends from a diversion point on the river about 18 miles upstream from Parker, Arizona, to a proposed terminal reservoir at the Cajalco site, about 12 miles south of Riverside, California. This portion of the line is composed chiefly of open lined canal, cut-and-cover conduit, and tunnels, of the forms and dimensions shown in the accompanying sketches. Concrete or steel pressure pipe is required for crossing streams and other depressions. The main aqueduct will be 241.5 miles in length, composed of 91.5 miles of tunnel, 64.9 miles of lined canal, 55.6 miles of cut-and-cover conduit, 28.3 miles of pressure lines and siphons, and 1.2 miles of passages through reservoirs. The aqueduct is designed for a flow of 1,605 cubic feet of water per second or approximately one billion gallons per day. With a 7% allowance for shut-downs, this gives an average flow of 1,500 cubic feet per second.

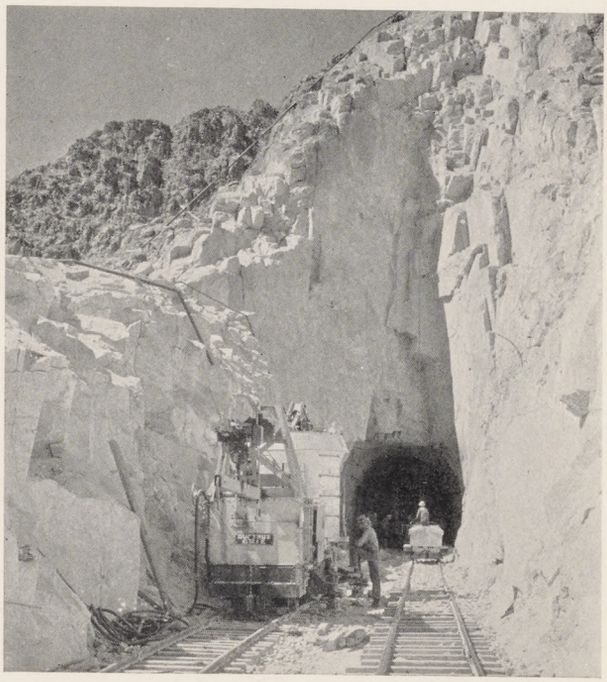
This full flow will not be needed in the first years of operation, but it is uneconomical to construct the tunnels, canals, and conduits, of the main aqueduct, to partial capacity and to enlarge or duplicate them in later years. Hence, they are being constructed to full capacity. The pumping plants and pipe lines may be economically built in parallel units, and reservoirs may be built in stages. Portions of these facilities not needed during the first years of operation are to be left to future construction. The cost of these items need not be incurred until needed, and at that time the community can well afford the additional expense. The work scheduled as a part of the initial construction will provide a complete project capable of delivering water to each city of the District, with reserve capacity for several years, and capable of being quickly and cheaply expanded to meet the growing need for water.

Diversion Works

Although the District's supply will come from waters stored above Boulder dam, it is not to be diverted directly from that reservoir but will be released into the river channel and recovered at the proposed Parker diversion damsite. This dam will raise the water about 72 feet from present river level to an elevation 450 feet above sea level, thus providing a large storage basin for desilting and clarifying the water. The dam will be of the concrete arched type and is to be constructed and operated for the District by the United States Bureau of Reclamation. It will be owned by the United States.

Pumping Requirements

As shown by the profile, pages 6 and 7, the water level in the Parker reservoir is lower than the major



East portal of Coxcomb tunnel.



portion of the area to be served with Colorado River water and much lower than the highest portions of the desert area crossed by the aqueduct. Consequently, the water must be pumped. The distribution of pumping stations along the line is shown on the profile. There are five plants in all, two at the river and three others as the line approaches Shaver's Summit. The total lift is 1,618 feet. The individual lifts vary from 147 feet to 440 feet. Each pumping plant will ultimately contain nine units of about 200 second feet capacity each, which will allow one spare unit. These units will not all be installed at the beginning of operations, but will be added from time to time as the demand for water requires. Flow from the pumps will be equalized by small reservoirs at Gene Wash and Copper Basin and a larger one at Hayfield, the location of the final pump lift.

Power for Pumping

Power for operating the District's pumps is to be obtained from the Government's plant at Boulder dam, under the provisions of a contract with the Secretary of the Interior, dated April 26, 1930. Under this contract, the District is allotted 36% of the firm power, and preferred right to all secondary power produced at the dam. Firm power is to be paid for at 1.63 mills per kw-hr. and secondary power at 0.5 mills per kw-hr., the District to pay for the installation and operation of generating machinery separately. The District will build and operate its own transmission lines. The District will also have the right to develop power at Parker dam and at such drops as may occur in the aqueduct distributing system.

The Distributing System

The main aqueduct is to terminate in a storage reservoir at Cajalco. From this point, the flow is to be con-

veyed to the member cities in pressure lines, conduits, and tunnels. Retail deliveries will not be made by the District but by the water departments of the various cities. Only the essential parts of the distributing system are to be built at first, additional units to be constructed as needed. The details of the distribution works have not been finally approved. One of several alternative plans for the first development is shown on the map, pages 6 and 7. Other lines, at lower elevations, are to be added as needed. The initial expenditure is to be kept to the minimum consistent with good design and adequate service of initial demand. Every city will be supplied, either directly or through an exchange agreement with some other city.

Construction Started in 1932

The long period of investigation and study was brought to a close near the end of 1932, with the completion of preliminary arrangements for financing the work, and the actual building of the aqueduct was begun. Except where for some reason such a procedure is inexpedient, those parts of the work requiring the longest time to construct are being started first, with others following in such order that all will be finished at approximately the same time. This avoids the deterioration of unused finished works, and reduces interest during construction to a minimum.

A condensed construction program, revised to April 30, 1934, is reproduced herewith. Such a program is subject to constant revision to maintain a proper balance between construction costs and interest during construction as material and money markets change.

Tentative Construction Program

Features	Date for commencing construction	Date construction to be completed
Construction utilities, roads, water and power supply, communication-main systems	Dec. 14, 1932	Jan. 1, 1934
Diversion and auxiliary storage	July 1, 1934	July 1, 1937
Tunnels	Jan. 1, 1933	Dec. 15, 1938
Conduit, canal, and siphon	Oct. 1, 1934	Oct. 1, 1938
Pumping plants	Sept. 1, 1936	Oct. 1, 1938
Transmission lines	Sept. 1, 1936	Oct. 1, 1938
Terminal storage	Jan. 1, 1936	Dec. 1, 1938
Distribution system and feeders	April 1, 1935	Dec. 1, 1938

Construction Utilities Provided First

The eastern portion of the aqueduct lies in a desolate region in which there is no water nor any of the ordinary facilities for living and for carrying on the required construction work. It was necessary for the District to build 148 miles of surfaced highway, 468 miles of high voltage power lines, 1,049 circuit miles of telephone line, and 180 miles of water supply lines with necessary wells and pumping equipment, before construction of the main features could be undertaken. These utilities are now completed.

Construction Accomplished to Date

The 13-mile tunnel under the San Jacinto Mountain will require a longer time to construct than any other single feature, consequently, it was the first to be advertised. Contract for its construction was let February 10, 1933. The East and West Coachella tunnels were authorized for construction by District forces on December 21, 1932, and contracts followed for other tunnels until now work is under way on all tunnels, a total of 91.5 miles. Up to May 1, 1934, 25% of the excavation on these tunnels had been completed. Contracts for aqueduct construction entered into and the progress made on each of them up to May 1, 1934, are tabulated herewith. Contracts for canals, siphons and conduits are being prepared for letting as rapidly as required. Construction of the distribution system will be started in the near future.

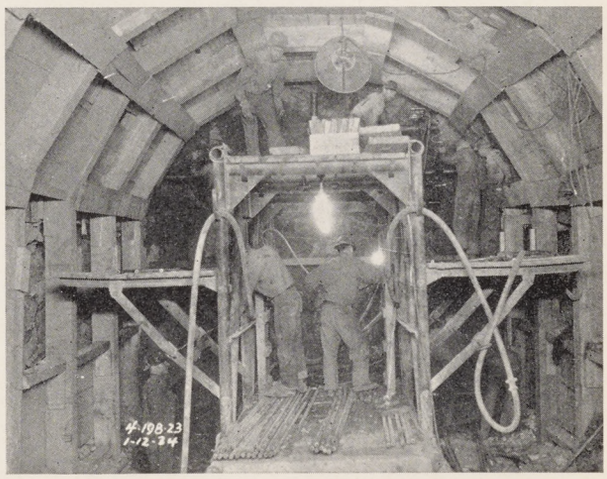
Tunnel Contractors and Progress Made by Each to May 1, 1934

Contractor	Tunnel	Contract length-feet	Progress to date-feet	Contract price
Walsh Constr. Co.	Colorado River	5,640	0	
	Copper Basin	12,280	4,765*	$4,357,780.40
	Whipple Mt.	32,190	5,333*	
Winston Bros. Co.	East Iron Mt.	23,633	4,085*	3,768,314.35
	Coxcomb	17,530	4,081	
Utah Constr. Co.	West Iron Mt.	16,172	5,780	1,699,705.00
Broderick & Gordon	E. Eagle Mt.	9.460	0	
	E. port on of W. Eagle	15,669	1,742*	2,348,334.00
Dixon & Bent Bros.	W. portion of W. Eagle	10,649	3,817	1,025,898.00
Hunkin-Conkey Co.	Hayfield No. 1	9,677	1,704*	814,952.40
Shofner & Gordon	Hayfield No. 2	5,360	1,931	471,889.00
J. F. Shea, Inc.	Cottonwood	20,088	9,380	1,857,062.00
Morrison-Knudsen	Mecca Pass #1, 2, & 3	5,875	3,387	575,685.00
West Constr. Co.	Whitewater Nos. 1 & 2	10.040	4,808	1,051,637.50
Wenzel & Henoch	San Jacinto	67,408	2,696*	7,339,100.00
Hamilton & Gleason	Bernasconi	5,920	2,976	412,055.00
Dravo Contr. Co.	Valverde	37,150	12,991*	3,136,603.00
TOTALS		304,741	69,476	$28,859,015.65**

* Access works also completed.
** Contract price only; does not include District furnished materials and services nor work in progress by District forces.

Estimate of Cost

As previously stated, portions of divisible features are to be deferred for future construction. The original



A typical tunnel drilling crew.

estimate of cost for initial construction was $218,844,000. Favorable contracts, already let and deferment of some items for later construction, permit a reduction of this total to $209,420,000. The principal items making up this sum and the cost of deferred items are summarized in the following tabulation:

Initial Construction	
Roads, water, and power supply, communication, and buildings	$ 5,577,000
Diversion and auxiliary storage	15,289,000
Tunnels	55,448,000
Conduit, canal, and siphons	48,540,000
Pumping plants	14,559,000
Transmission system	5,191,000
Terminal storage	18,340,000
Distribution lines and feeders	43,976,000
Preliminary investigations	2,500,000
Total	$209,420,000
Deferred Items	
Parker power plant	$ 3,085,000
Siphons	8,709,000
Pumping plants	7,941,000
Transmission system	2,500,000
Terminal storage	10,173,000
Distribution lines and feeders	40,417,000
Total	$72,825,000
Grand total, $282,245,000	

Source of District Finances

Funds for the District's construction work are derived from the sale of bonds. An issue of $220,000,000 was authorized by popular vote on September 29, 1931. This issue provides funds for the construction of the project, including the diversion works at the point of intake, the 241.5-mile main aqueduct from the river to a terminal near Riverside, the necessary pumping plants, the storage reservoirs required at the end of the aqueduct, and the pipe lines and other distributing works required to deliver the water from the terminal of the main aqueduct into the water supply systems of the various member cities. The bonds voted are required to be retired, in substantially equal amounts annually, in from 15 to 50 years from date of sale. As is required by law, the legality of this issue has been established by court action. On June 2, 1932, the Supreme Court of the State of California handed down a decree declaring this bond issue to be valid and legal in every particular. Before bonds from this issue became available, the making of surveys, preparing of plans, estimates, and carrying on of other necessary preliminary activities were financed by small tax levies. Also, the earliest part of the investigational work was carried on and financed by the City of Los Angeles, using the proceeds of a small city bond issue and by funds derived from other city sources.

Bonds Sold to May 1, 1934

The District's enabling act permits it to dispose of bonds only through public sale. Under date of Septem-

Financial Status of the Metropolitan District of Southern California, as of April 30, 1934

Source	Financing arranged	Funds disbursed	Balance available	Total commitments
City of Los Angeles—1925 bonds outstanding	$1,720,000.00	$1,720,000.00	.....	$2,610,775.60
Disbursed by city of Los Angeles from revenue funds	890,775.60	890,775.60 (a)	.....	
Funds from sale of 1931 District bonds to R. F. C.:				
Received	18,144,000.00	16,315,081.75	$1,828,918.25	
Sold but funds not delivered	4,032,000.00	.....		63,544,772.00
Committed — actual sale not yet made	17,824,000.00	.....	21,856,000.00	
General and other District funds: general funds	3,499,839.62			
Miscellaneous collections (faithful performance deposit and interest on bank deposit)	282,087.41			
Accrued interest on bonds sold to R. F. C.	151,200.00			
Preliminary engineering and organization expense disbursed from general funds		2,301,132.86		2,301,132.86
Interest paid on outstanding District bonds		453,600.00		453,600.00
Balance available			1,178,394.17	619,800.00 (b)
P. W. A. loan and grant—				
Parker dam	2,000,000.00		2,000,000.00	13,035,000.00
Total	$48,543,902.63	$21,680,590.21	$26,863,312.42	$82,565,080.46

(a) Includes $280,000.00 of 1925 bonds retired.

(b) Interest to be paid on District bonds between May 1 and December 31, 1934.

ber 13, 1932, the Reconstruction Finance Corporation signed an agreement to bid, at an interest rate not higher than 5%, on District bonds up to a total of $40,000,000, in such lots as might from time to time be offered. Bonds have been sold under this agreement, as follows:

Amount	Date of sale	Date of bonds
$2,016,000	Dec. 12, 1932	Nov. 1, 1932
$4,032,000	Feb. 3, 1933	Feb. 1, 1933
$8,064,000	June 16, 1933	July 1, 1933
$8,064,000	Jan. 19, 1934	Feb. 1, 1934

The agreement with the R.F.C. provides for serial bonds maturing in 15 to 50 years from date of sale and bearing interest at 5%. Effective April 1, 1934, this rate was reduced to 4% for a period of 5 years, or for such portion of that time as the bonds remain in the possession of the R.F.C.

In addition to the above, the Federal Emergency Administration of Public Works has agreed to advance $2,000,000 to be used by the Bureau of Reclamation for starting the Parker dam. The total estimate for this feature is $13,804,000. The agreement with the P.W.A. provides that 30% of the expenditure for labor and materials shall be in the form of a grant, not to be repaid. The remainder is repayable in 5 to 40 years, with interest at 4%. A condensed statement of the District's financial status, as of April 30, 1934, is shown on the accompanying table. The disbursements shown in this tabulation cover all expenditures made on the project to date for preliminary investigations, surveys, plans, and general expenses; also, the cost of building the necessary construction utilities, excavating more than 22 miles of tunnel, providing plant equipment, etc., for completing additional portions of the work and for carrying on all District activities necessary to bring the project to its present state of completion. Although a balance of available financing amounting to $26,863,312.42 is shown for on April 30, 1934, the commitments on work already under way greatly exceed the funds contracted for.

Security for Bonds

The project is self-liquidating. A reasonable return on the water delivered will ultimately liquidate the entire investment and repay many times over for any small tax levies that may be required during the construction period or the early years of operation. Water in Southern California is a vital necessity and a reasonable demand for Colorado River water is assured. Both interest and principal on the District bonds are further guaranteed by the full power of taxation in thirteen prosperous cities. There is every reason to expect that other cities will come in to the District as the demand for water increases, which will serve to strengthen the already ample security of the District bonds.

Funds for Redemption and Interest

After the aqueduct is in operation, it is contemplated that funds for meeting all District expenditures, including bond redemption and interest charges, will be derived from water sales. This can be accomplished by a small increase to existing moderate retail water prices, leaving sale prices still below the average for the United States and considerably lower than in other sections of California. A tabular analysis of the estimated charges is shown herewith.

Sale Price of Water Required
To Pay All Capital and Operating Charges on Colorado River Aqueduct

Item		1940	1950	1960	1970	1980
1	Estimated quantity of water sold from present sources, acre feet per year	366,100	464,600	477,100	489,700	502,100
2	Estimated quantity of Colorado River water sold, acre feet per year	195,500	319,300	484,100	635,300	762,400
3	Estimated quantity of industrial and domestic water sold, all sources, acre feet per year (Item 1 + Item 2)	561,600	783,900	961,200	1,125,000	1,264,500
4	Revenue from sale of local water at present average sale price or 12c per 100 cubic feet (Item 1 × $52.252)	$19,129,000	$24,276,000	$24,929,000	$25,587,000	$26,236,000
5	Estimated capital charges Colorado River aqueduct	$10,395,000	$14,172,000	$15,401,000	$14,253,000	$11,390,000
6	Estimated operation and maintenance charges Colorado River aqueduct	$ 5,177,000	$ 5,529,000	$ 6,221,000	$ 6,908,000	$ 7,332,000
7	Estimated cost to member cities to distribute Colorado River water at 7c per 100 cubic feet (Item 2 × $30.492)	$ 5,961,000	$ 9,736,000	$14,761,000	$19,372,000	$23,246,000
8	Total revenue required to pay all charges, including Colorado River aqueduct (Items 4 + 5 + 6 + 7)	$40,662,000	$53,713,000	$61,312,000	$66,120,000	$68,204,000
9	Required retail sale price of water to pay all charges, including Colo. R. aqueduct, cents per 100 cu. ft. (Item 8 ÷ Item 3)	16.62	15.73	14.64	13.49	12.38
10	Required increase in sale price of water to pay all charges of Colo. R. aqueduct, cents per 100 cu. ft. (Item 9 — 12c)	4.62	3.73	2.64	1.49	0.38

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Rancher; banker
Los Angeles

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Head, Department of Civil Engnieering,
California Institute of Technology
Pasadena

S. H. FINLEY - - - - *Secretary, Board of Directors*
Retired civil engineer; banker
Santa Ana

F. E. WEYMOUTH - *General Manager and Chief Engineer*

D. W. PONTIUS - - - - - - - - - - - - *Controller*
President, Pacific Electric Railway Company
Los Angeles

J. M. LUNEY - - - - - - - - - *Assistant Controller*

CHARLES H. TOLL - - - - - - - - - - *Treasurer*
Vice-President, Security-First National Bank
Los Angeles

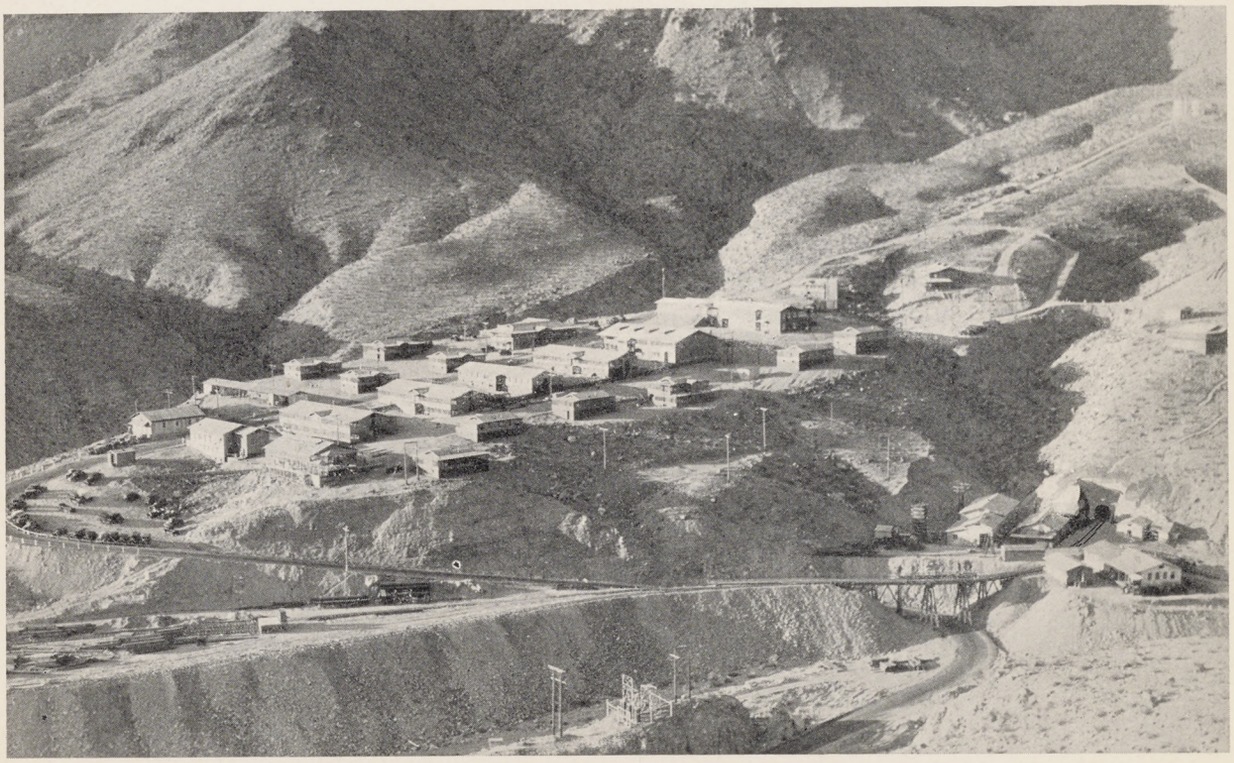
JAMES H. HOWARD - - - - - - - *General Counsel*

DIRECTORS

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Beverly Hills - - - - - - - - Geo. R. Barker	Los Angeles - - - - - - - - - D. W. Pontius
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ENGINEERING STAFF

General Manager and Chief Engineer F. E. Weymouth	Chief Electrical Engineer - - - - - - J. M. Gaylord
Assistant General Manager - - - - J. L. Burkholder	General Superintendent of Construction - - James Munn
Assistant Chief Engineer - - - - - Julian Hinds	Construction Engineer - - - - - - - - - J. B. Bond



Construction headquarters for 36 miles of Coachella tunnels. Berdoo adit in right foreground.

WHT. BR. 0242